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(71) Applicant *(for all designated States except US)*: **STRICKER, Kenneth, Bernard** [ZA/ZA]; 36 Brutor Road, Bryanston, 2021, Gauteng Province (ZA).

(71) Applicant and
(72) Inventor: **WOODWARD, Nigel, George** [GB/ZA]; 20 Windemere, Lakeside Village, 1645, Gauteng Province (ZA).

(74) Agent: **JOHN & Kernick**; P.O. Box 3511, Halfway House, Midrand, 1685 (ZA).

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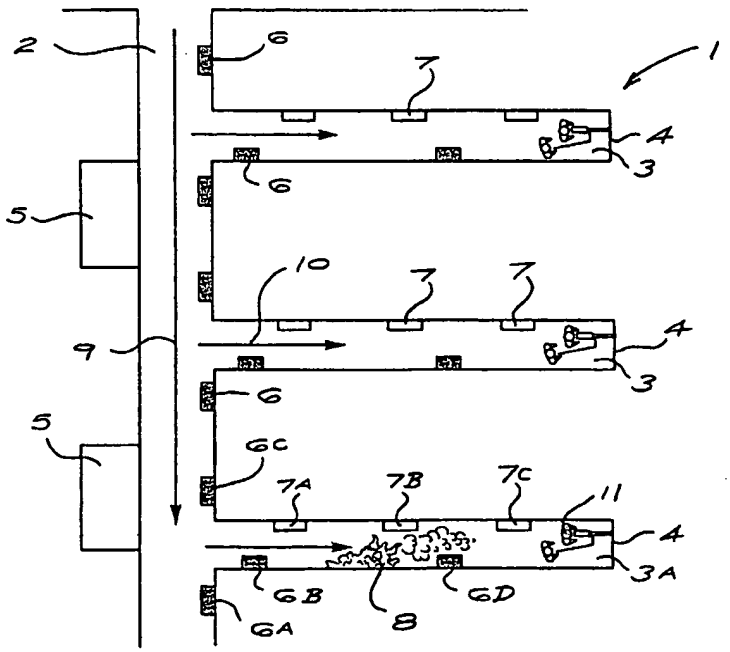
(54) Title: SAFETY SYSTEM



(57) Abstract: A safety system including an event sensor (6), a source (7) of non-toxic and non-flammable alarm gas, and control means to release the alarm gas in response to a signal received from the event sensor (6) in response to the occurrence of a predeterminable event (8). The invention also disclose a method for operating a safety system in an underground mine (1).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

SAFETY SYSTEM

FIELD OF THE INVENTION

This invention relates to a safety system, in particular but not limited to, an underground mine safety system.

BACKGROUND TO THE INVENTION

One of the main concerns in underground mining operations is the safety of miners. Serious threats to the safety of miners include the presence of gases, the occurrence of earth tremors, and the breakout of fires in mine development ends and passageways.

Mine personnel frequently work in passages that branch out from main hauling ways, typically up to 1000m meters away. If a fire breaks out in a main hauling way the miners at the work face have to rely on someone else warning them in time to evacuate. In addition, conventional alarms are often not heard because miners have to wear hearing protection against the intense noise of mining operations.

It is therefore not always possible for miners to see a visual alarm system such as a flashing light, or to hear a siren when an alarm is activated.

For the same reasons the reaction time of ground level emergency teams are also often delayed.

It could also happen that miners are exposed to noxious and flammable gases such as methane or carbon monoxide that could lead to injury or death of the miners. It is desirable that miners be warned as soon as possible about the presence of such gases.

One type of existing warning system is the so-called "stench gas" warning system. This system uses an extremely unpleasant gas to warn miners of imminent danger. The particular gas is unpleasant to the point of being nauseating.

In the event of fire or other emergency the stench gas is introduced into the main ventilation system of the mine from where it spreads through the entire mine.

This has several disadvantages, which in many instances have led to resistance to its use. One disadvantage is that the stench gas spreads through the entire mine, or at least a substantial part of it. Once the particular event has been taken care of the workers have to wait until the unpleasant gas has dissipated before they can resume work. This obviously leads to loss of otherwise production time.

Another bigger problem is that in some instances the gas causes nausea which may lead to vomiting. If a miner is in a smoky environment where he has to rely on breathing apparatus to pass through or survive in, vomiting may force him to

remove his mask. This exposes him to the smoke which he was trying to avoid in the first place.

Another disadvantage is that the warning effect of the stench gas system is dependent on the flow of air through the ventilation system of the mine. It is possible, and in some instances most likely, that for example smoke from a fire will reach miners at a workplace before the stench gas will reach them. This makes the stench gas warning system ineffective in such a case. The same is true for other toxic gases.

In the event of a small fire in a remote part of a mine the release of stench gas into the ventilation system will cause the entire mine, or at least a substantial part of it, to be evacuated. This results in unnecessary loss of productive time if the fire can be handled efficiently enough to not warrant closure of the entire mine.

There are also other instances where it is also difficult or impossible for people to react in time to a visual or auditory alarm system. An example of this is old age homes where there are usually people with poor hearing or eyesight, or both. Other examples include facilities for the care the deaf, blind or otherwise physically impaired people.

OBJECT OF THE INVENTION

It is an object of this invention to provide a safety system that at least partly alleviates some of the abovementioned problems.

SUMMARY OF THE INVENTION

In accordance with this invention there is provided a safety system comprising at least one event sensor, a source of pressurized non-toxic and non-flammable

alarm gas, and control means to release the alarm gas in response to a signal received from the event sensor in response to the occurrence of a predeterminable event.

There is also provided for the event sensor to be remotely located from the source of pressurized gas and for the signal sent from the event sensor to be distinctive of the event that triggered the event sensor.

There is also provided for the event sensor to comprise at least one of a gas sensor, an earth timer sensor; and a temperature sensor, and for the signal from the event sensor to be indicative of the type of event.

The invention further provides for the event sensor to include at least one gas sensor, preferably multiple gas sensors, and for the signal sent from the at least one gas sensor to be indicative of the type of gas sensed.

There is further provided for the signal to be indicative of respectively a gas concentration, a magnitude of an earth tremor sensed, or a temperature reading of the event sensor environment.

The invention also provides for the event sensor to require sensing of an event for a predeterminable time, alternatively for a predeterminable level of the event to be sensed, further alternatively for a predeterminable level of the event to be sensed for a predeterminable time, before a signal is sent to the control means.

There is further provided for the source of alarm gas to be a pressurized gas container, for the control means to include an electrically actuated valve in the container, and for the control means to include an electricity supply for the valve.

There is further provided for the alarm gas to be scented nitrogen gas, and for the gas to be citrus scented.

There is further provided for the alarm gas to be released into the intake airflow system of a mine and for the alarm gas to be carried by the airflow to a working face of the mine.

There is further provided for the event sensor to transmit the signal to the control means by means of a fixed time connection, alternatively wireless communication including radio waves, microwaves and infrared waves.

The invention also provides for the safety system to include a siren and an alarm light and for the control means to activate the siren and alarm light in addition to releasing the alarm gas in response to the signal received from the event sensor.

The invention also provides for a signal from the event sensor to be receivable by a remote control station and for the remote control station to be located on surface level.

The invention also provides for a method of operating a safety system including the steps of:

a. Installing at least one event sensor in a first predeterminable area;
b. Installing a source of pressurized non-toxic and non-flammable alarm gas in a second predeterminable area;
c. Transmitting a signal from the event sensor to control means associated with the pressurised gas container upon sensing of a predeterminable event in the first area;
d. Releasing alarm gas into the second area upon reception of the signal.

There is also provided for the first area to be a mine passage way and the second area to be proximate a mine working face.

There is further provided for the method to include the step of releasing the alarm gas in the intake airflow of the mine proximate the mine working face.

There is also provided for the method to include the step maintaining a predetermined maximum distance between the source of pressurised gas and the mine working face.

There is further provide for the method to include the step of installing additional pressurised gas containers upon progression of the mine working face, alternatively for relocation the already installed sources of pressurised gas to maintain the predetermined maximum distance between the source of pressurised gas and the mine working face.

There is still further provided for the method to include the step of each event sensor transmitting an alarm signal across a predeterminable range.

There is further provided for each alarm signal to also be transmitted to a remotely control station.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention will be described below by way of example only and with reference to the accompanying diagrammatic drawings in which:

Figure 1 is a plan view of a mine in which a safety system has been installed.

Figure 2 is a part sectional elevation of a housing for a pressurised gas container.

DETAILED DESCRIPTION OF THE DRAWINGS

In the embodiment of the invention shown in figure 1 a plan view of a mine (1) is shown. The mine (1) includes a main hauling way (2) and several mine development ends (3). Each development end provides a stope working face (4) at which miners excavates rock. The length of a development end (3) can typically be in the order of about 1000m.

The mine is ventilated through an air intake flow system (not shown). Air (9) is forced through the mine workings in the system and down (10) the development ends until it reaches the working faces (4).

In the main hauling way (2) there are several refuge bays (5) to which miners can retreat in case of emergency. Also in the main hauling way and in the development ends there are several event sensors (6) and sources of pressurized gas (7). The event sensors (6a, 6b, 6c, 6d) in a specific area are linked by means of electrical cable to specific sources of pressurized gas (7a, 7b, 7c) in that vicinity. The sources (7a, 7b, 7c) are chosen to be in a predetermined range from the event sensors (6a, 6b, 6c, 6d) and also to be in the direction of airflow from the event sensors (6a, 6b, 6c, 6d). This is done to ensure that any area that could be effected by smoke spreading with the airflow is warned in time about the danger.

In the event of for example a fire (8) in the hauling way (2) smoke from the fire will travel down the hauling way (2) and enter at least development end 3a, from where the airflow from the air intake flow system will carry the smoke (not shown) towards the working face (4). Once the smoke reaches the working face (4) the miners (11), if not warned in time, will have to don their safety gear and walk back towards the refuge bays through the smoke and possibly through the spreading fire (8).

The event sensors (6a, 6b, 6c) proximate the entrance to the development end (3a) will sense the smoke and if it senses the smoke for more than the preset 20 seconds, it will send a signal to the linked gas sources (7a, 7b, 7c) and the ground level control room (not shown).

Upon receipt of the signal the control means in the linked gas sources (7a, 7b, 7c) will open the pressurized gas containers (not shown) to release citrus scented nitrogen gas, which is both non-toxic and non-flammable, into the airflow of the intake air flow system of the mine. The citrus scented gas will be transported by the airflow until it reaches the workface. As soon as the miners smell the citrus scented gas they will realize that an alarm has been triggered. They then have the opportunity to don their safety gear and walk back towards the refuge bays (5) in the hauling way (2).

Detail of an alarm unit (20) for a pressurized gas source is shown in Figure 2. It shows a metal box (21) that is mountable to a wall of a mine development end (3). The box (21) includes a conventional alarm light (22) and audible siren (23). A container (24) with pressurized gas therein is secured inside the alarm unit (20). The gas container (24) has an outlet (25) that extends through the alarm unit outer cover (not shown) to enable the gas to be released outside the unit (20). The unit (20) has a lock (26) to prevent tampering with the equipment.

It will be apparent to those skilled in the art that this has the advantage that the miners at the workface are alerted within just more than 20 seconds of the occurrence of an event that requires evacuation. This in contrast to what is currently the case where several critical minutes, or even longer, may pass without the miners knowing about the event. Indeed, it often happens that miners only become aware of an event once they smell the smoke at the work

face. It has been established in trials that the citrus scented gas can be smelled up to as much as 600m away from its source.

The same applies for the presence of noxious gases where miners would only become aware of the presence of the gases when other portable gas detection instruments they carry warns them of the presence of such gases. In the same manner miners can be warned of an earth tremor in another part of the mine which would also increase the time they have to react, or of possibly dangerous rise in temperature in an area of the mine.

As mentioned before the event sensors (6a, 6b, 6c) also send their signals to a ground level control room. The control room will have the ability to immediately identify the type of event (fire, type of noxious gas, earth tremor, environment temperature), the magnitude of the event (gas concentration, magnitude of the tremor on for instance the Richter scale, specific temperature), and the distribution of the event (from the number and spread of event sensors sending signals) as well as the spread of the for instance a fire (by following the sequence in which event sensors send signals). This will enable the control room to take the most appropriate action to combat the event, which could also save lives, focuses the action to the appropriate area and avoids unnecessary disruptions to unaffected areas.

As the normal mining operations continue the gas sources (7) can be moved along the development end to remain in close proximity to the working face, or preferably new gas sources can be installed once the working face has moved a predetermined distance (which should be less than the distance of about 600m over which the citrus scented gas can reliably be smelled).

It will also be clear that this allows a gas warning to be sent to the mine workers at a working face that will not cause them to become nauseas and possibly

vomit. This is extremely unpleasant for the successful evacuation of the mine in which miners have to wear breathing apparatus and pass through thick smoke.

Part of the control of the mine includes temperature sensing in the passages. By sensing the temperature of the environment close to the miners it is possible to react quicker to a dangerous rise in temperature in this environment

It will be understood that this is only one embodiment of the invention. It is possible to alter some aspects of the embodiment without departing from the scope of the invention.

It is for instance possible to install a similar system in an old age home where there are normally people who have either poor hearing or eyesight or both. By using smell as an alarm signal the probability of the people reacting to an alarm in time increases. Similar systems could also be installed in other care facilities, in domestic homes, restaurants, and offices. In all of these locations the installation of the safety system will at least increase the probability of people reacting to an alarm in time.

CLAIMS

1. A safety system comprising at least one event sensor, a source of non-toxic and non-flammable alarm gas, and control means to release the alarm gas in response to a signal received from the event sensor in response to the occurrence of a predeterminable event.

2. A safety system as claimed in claim 1 in which the event sensor is remotely located from the source of gas.

3. A safety system as claimed in claim 1 or 2 in which the signal sent from the event sensor is distinctive of the event that triggered the event sensor.

4. A safety system as claimed in any of the preceding claims in which the event sensor includes at least one of a gas sensor, an earth tremor sensor, and a temperature sensor.

5. A safety system as claimed in claim 4 in which the signal sent from the event sensor is indicative of the type of event.

6. A safety system as claimed in claim 5 in which the event sensor is at least one gas sensor and for the signal sent from the gas sensor to be indicative of the type of gas sensed.

7. A safety system as claimed in claim 6 in which the signal sent from the gas sensor is indicative of a gas concentration sensed by the event sensor.

8. A safety system as claimed in claim 4 or 5 in which the signal from the earth tremor sensor is indicative of a magnitude of an earth tremor sensed.

9. A safety system as claimed in claim 4 or 5 in which the signal received from a temperature sensor is indicative of a temperature reading of the event sensor environment.

10. A safety system as claimed in any one of the previous claims in which an event has to be sensed for a predeterminable time before the signal is sent to the control means.

11. A safety system as claimed in any one of claims 1 to 9 in which a predeterminable level of an event has to be sensed before the signal is sent to the control means.

12. A safety system as claimed in any one of claims 1 to 9 in which a predeterminable level of an event has to be sensed for predeterminable time before the signal is sent to the control means.

13. A safety system as claimed in any one of claims 1 to 12 in which the source of gas is a pressurizable container.

14. A safety system as claimed in claim 13 in which the control means includes an actuated valve in the container.

15. A safety system as claimed in any one of claims 1 to 14 in which the control means valve is electrically, mechanically or hydraulically actuated and the control means includes electrical, mechanical or hydraulical supply for the valve.

16. A safety system as claimed in any of the preceding claims in which the alarm gas is fragranced.

17. A safety system as claimed in claim 16 in which the gas has a citrus fragrance.

18. A safety system as claimed in any one of the preceding claims in which the gas is nitrogen gas.

19. A safety as claimed in any of the preceding claims in which the alarm gas is released into the intake airflow system of a mine and the alarm gas is carried by the airflow to a working face of the mine.

20. A safety system as claimed in any of the preceding claims in which the event sensor transmits the signal to the control means by means of at least one of a fixed line connection or wireless communication.

21. A safety system as claimed in claim 20 in which the wireless communication includes radio waves, microwaves and infrared waves.

22. A safety system as claimed in any one of the preceding claims in which the signal from the event sensor is receivable by a remote control station.

23. A safety system as claimed in claim 22 in which the remote control station is located on the surface level.

24. A safety system as claimed in any of the preceding claims which includes a siren and an alarm light and the control means activates

the siren and alarm light in addition to releasing the alarm gas in response to the signal received from the event sensor.

25. A method of operating a safety system including the steps of:

a. installing at least one event sensor in a first predeterminable area;
b. installing a source of pressurized non-toxic and non-flammable alarm gas in a second predeterminable area;
c. transmitting a signal from the event sensor to control means associated with the pressurised gas container upon sensing of a predeterminable event in the first area;
d. releasing alarm gas into the second area upon reception of the signal.

26. A method as claimed in claim 25 in which the first area is a mine passage way and the second area is proximate a mine working face.

27. A method as claimed in claim 26 in which the alarm gas is released in the intake airflow of the mine proximate the mine working face.

28. A method as claimed in claim 26 or 27 in which a predetermined maximum distance is maintained between the source of pressurised gas and the mine working face.

29. A method as claimed in claim 28 which includes the step of installing additional pressurised gas containers upon progression of the mine working face.

30. A method as claimed in claim which includes the step of relocating already installed sources of pressurised gas.

31. A method as claimed in any one of claims 25 to 30 in each event sensor transmits an alarm signal across a predeterminable range.

32. A method as claimed in claim 31 in which each alarm signal is also transmitted to a remotely located control station.

33. A safety system substantially as herein described with reference to the Figures 1 and 2.

34. A method of operating a safety system substantially as herein described with reference to Figure 1.

AMENDED CLAIMS

[received by the International Bureau on 13 March 2003 (13.03.03);
original claims 1-34 replaced by new claims 1-33 (4 pages)]

1. A safety system comprising at least one event sensor, a source of non-toxic and non-flammable fragranced alarm gas, and control means to release the alarm gas in response to a signal received from the event sensor in response to the occurrence of an anticipated event.

2. A safety system as claimed in claim 1 in which the event sensor is remotely located from the source of gas.

3. A safety system as claimed in claim 1 to 2 in which the signal sent from the event sensor is distinctive of the event that triggered the event sensor.

4. A safety system as claimed in any of the preceding claims in which the event sensor includes at least one of a gas sensor, an earth tremor sensor, and a temperature sensor.

5. A safety system as claimed in claim 4 in which the signal sent from the event sensor is indicative of the type of event.

6. A safety system as claimed in claim 5 in which the event sensor is at least one gas sensor and for the signal sent from the gas sensor to be indicative of the type of gas sensed.

7. A safety system as claimed in claim 6 in which the signal sent from the gas sensor is indicative of a gas concentration sensed by the event sensor.

16. A safety system as claimed in any one of claims 1 to 15 in which the gas has a citrus fragrance.

17. A safety system as claimed in any one of the preceding claims in which the gas is nitrogen gas.

18. A safety as claimed in any of the preceding claims in which the alarm gas is released into the intake airflow system of a mine and the alarm gas is carried by the airflow to a working face of the mine.

19. A safety system as claimed in any of the preceding claims in which the event sensor transmits the signal to the control means by means of at least one of a fixed line connection or wireless communication.

20. A safety system as claimed in claim 19 in which the wireless communication includes radio waves, microwaves and infrared waves.

21. A safety system as claimed in any one of the preceding claims in which the signal from the event sensor is receivable by a remote control station.

22. A safety system as claimed in claim 21 in which the remote control station is located on the surface level.

23. A safety system as claimed in any of the preceding claims which includes a siren and an alarm light and the control means activates the siren and alarm light in addition to releasing the alarm gas in response to the signal received from the event sensor.

24. A method of operating a safety system including the steps of:

a. installing at least one event sensor in a first predeterminable area;
b. installing a source of pressurized non-toxic and non-flammable fragranced alarm gas in a second predeterminable area;
c. transmitting a signal from the event sensor to control means associated with the pressurised gas container upon sensing of an anticipated event in the first area;
d. releasing alarm gas into the second area upon reception of the signal.

25. A method as claimed in claim 24 in which the first area is a mine passage way and the second area is proximate a mine working face.

26. A method as claimed in claim 25 in which the alarm gas is released in the intake airflow of the mine proximate the mine working face.

27. A method as claimed in claim 25 or 26 in which a predetermined maximum distance is maintained between the source of pressurised gas and the mine working face.

28. A method as claimed in claim 27 which includes the step of installing additional pressurised gas containers upon progression of the mine working face.

29. A method as claimed in claim which includes the step of relocating already installed sources of pressurised gas.

30. A method as claimed in any one of claims 24 to 29 in each event sensor transmits an alarm signal across a predeterminable range.

31. A method as claimed in claim 30 in which each alarm signal is also transmitted to a remotely located control station.

32. A safety system substantially as herein described with reference to the Figures 1 and 2.

33. A method of operating a safety system substantially as herein described with reference to Figure 1.

STATEMENT UNDER ARTICLE 19

The applicant wishes to amend the claims of the application as shown below and to make the following statement under PCT Article 19 to explain the amendments, with reference to the cited prior art.

FR2811117

This patent relates to a device that is used to warn people of the presence of a specific material from a distance. A coloured, pressurised gas is released upon the occurrence of a specific event and the colour of the gas serves to warn emergency workers of the presence of a specific material.

This is typically used on freight containers and trucks hauling these (see figures 7-9) where the contents are supposed to be identified by markings on the container itself. A problem with the markings is that these are easily destroyed by fire. If so destroyed, emergency personnel responding to such an incident could be exposed to toxic materials without warning. It is also necessary for emergency personnel to know what the contents of the container is to be able to use the right fire extinguishing material; for example water or foam. A specific colour gas is associated with a specific hazardous material.

The Search Report specifically cites page 4, line 28 to page 5, line 20 as being relevant. This is a specific example of how this system is used. It includes a number of signalling means (2a to 2e) and triggering means (3) for the system. The triggering means is connected to a number of event sensors (4a to 4d). It is further stated that the device may be used with a vehicle, a transport container, a building, or a storage area. It also explains that the signalling means (2) includes a number of devices, such as a radio transmitter, light, smoke canister, and siren.

This patent is not directed at an alarm gas that signals by means of scent, or is that disclosed or even suggested. It should be noted that the preferred embodiment of the current patent application

includes a citrus fragranced gas. The fragrance of the gas is used to warn people of the occurrence of the specific event.

However, patent FR2811117 does disclose an alarm system that releases a gas in response to a signal received from an event sensor and is therefore relevant in that regard to claim 1. The applicant therefore proposes to amend claims 1 and 25 as shown in the Second Schedule hereto. Claim 16 is deleted as a result of the amendment.

This distinguishes these claims from this prior art document since the use of a fragranced alarm gas is not disclosed or even suggested in it.

WO9730313

This patent relates to a system for controlling the heating of a building to prevent a build-up of excess gas inside the building. It includes a sensor to detect the concentration of selected gas. If the concentration exceeds a predetermined level, the heating unit is disconnected (see page 7 line 21 to page 8 line 5).

The system further includes an audible alarm that is triggered in the event of the gas concentration exceeding the predetermined level, and an alarm signal could also be transmitted to emergency services.

This patent does not disclose or suggest the use of an alarm gas, specifically not scented alarm gas, which is triggered in response to an event.

US6063632

This patent relates to a method and device for detecting water leaks. An odorant and a water-soluble barrier is contained in a housing and placed on a leak prone area. If a leak occurs, the leaking water dissolves the barrier and the odorant is released which notifies people of the leak.

This patent does not disclose or suggest the use of an alarm gas, specifically not scented alarm gas, which is triggered in response to an event.

US552088

This patent relates to the old type stench gas warming systems used in mines. It claims a composition for use in such stench gas warning systems. The composition includes liquid mercaptan mixed with a non-flammable 1,1,1,2-tetrafluoroethane and an inert gas (nitrogen).

The patent discloses the use of this composition in a pressurised container, which is connected to the breathing system of a mine. When required, the container is opened manually and the gas is released into the air breathing system.

This is typical of the old type stench gas warning systems that is described in the background of the Applicant's specification.

This patent does not disclose or suggest the use of a fragranced alarm gas that is triggered in response to an event. The proposed amendment to claim 1 above should cover any objection relating to lack of novelty and lack of inventive step based on this patent.

CONCLUSION

The applicant submits that any objection based on the disclosures of the cited documents is overcome by the amendments to the claims. None of the cited documents alone or in combination with one or more of the other documents discloses or suggests a fragranced alarm gas system that releases the alarm gas in response to the occurrence of a predetermined event.

FIG 1

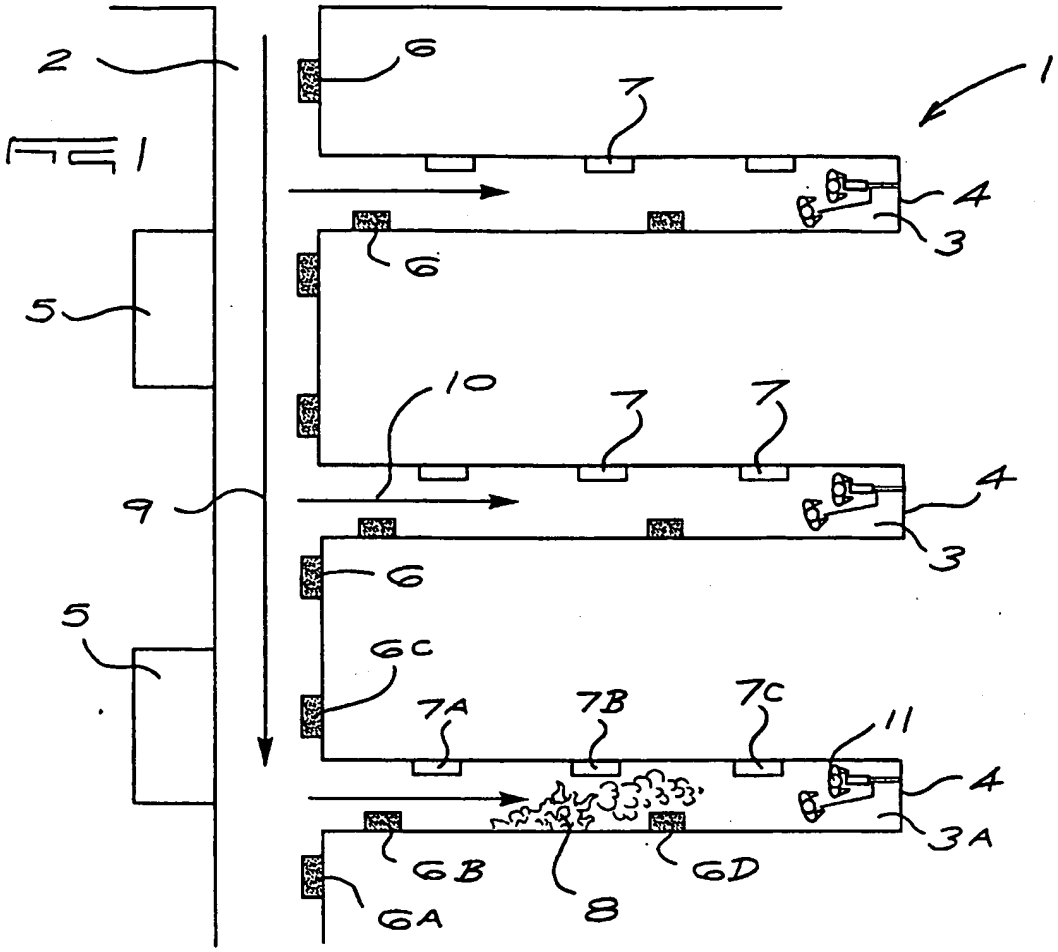
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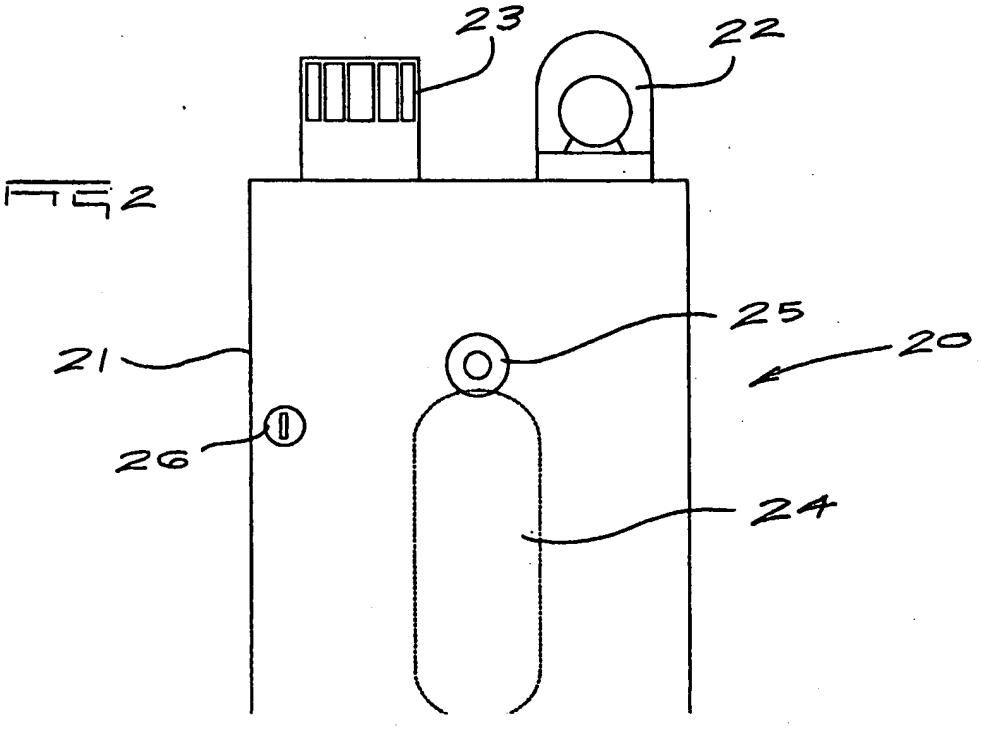
FIG 2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INTERNATIONAL SEARCH REPORT

PCT/IB 02/03870

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21F17/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21F G08B G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 811 117 A (GIAT IND SA) 4 January 2002 (2002-01-04) page 4, line 28 -page 5, line 20	1-5,9, 13-15, 20-22, 24,25
Y		6,7, 10-12, 16,17, 19,26,27
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[X] Further documents are listed in the continuation of box C.

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20 December 2002	03/01/2003

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